Hybrid Direct Drive PPU with Extended Operating Range, Phase I

Completed Technology Project (2012 - 2012)

Project Introduction

High-power electric propulsion with Hall thrusters has been proposed as a strong candidate for Electric Path missions, but conventional power processing units (PPUs) are complicated and the mass of the discharge power converters needs to be reduced. Direct Discharge Power Processing Units (DDUs) have been proposed as an alternative due to their simplicity and low mass, but the achievable operating range of thrust and ISP is significantly limited because power regulation for DDUs is only achieved through gas flow control, array offpointing or shunting. This proposal presents a compromise between PPUs and DDUs called a Hybrid Direct Drive Power Processing Unit (HDDU) that provides a wider operating range than DDUs while reducing the mass and increasing the efficiency compared to conventional PPUs. An HDDU provides filtering like a DDU, but it can additionally raise or lower the discharge voltage over a limited range. An HDDU only processes the power necessary to raise or lower the discharge voltage. Several different converter circuits can be used in an HDDU. One approach uses an isolated high-efficiency resonant DC-DC converter with connections that can be configured through a set of electromechanical relays. Another approach uses a novel soft-switching non-inverting buck-boost circuit that requires no relays, but is a little less efficient than resonant circuits. Straight-through direct drive operation is possible with either type of converter. The proposed HDDU would operate from an input voltage of 150 V to 300 V, and would provide 10 kW output power over a limited range such as from 150 V to 500 V. The HDDU approach is readily scalable by connecting modules in parallel because both proposed circuits naturally share output currents. The modular approach and enhanced operating range increase design re-use and reduce life-cycle costs. A Phase II project could include making a more flight-like discharge supply and adding heater, keeper and magnet supplies.

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Table of Contents

Project Introduction	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

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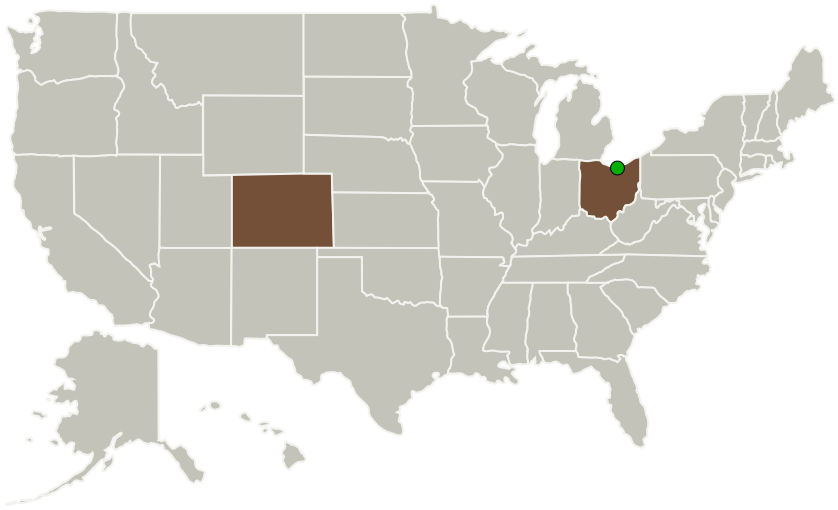
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Colorado Power Electronics, Inc.	Lead Organization	Industry Veteran-Owned Small Business (VOSB)	Fort Collins, Colorado
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Colorado	Ohio

Project Transitions

February 2012: Project Start

August 2012: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140307)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Colorado Power Electronics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Bryce L Hesterman

Co-Investigator:

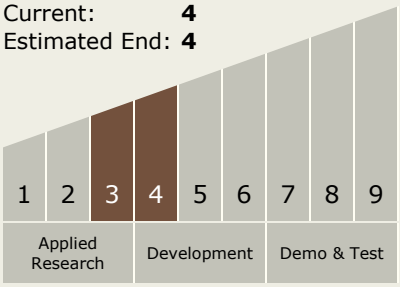
Bryce Hesterman

Hybrid Direct Drive PPU with Extended Operating Range, Phase I

Completed Technology Project (2012 - 2012)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.2 Electrostatic

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System